DESERT PLANT ADAPTATIONS

Environmental Stresses for Desert Plants:

1. Long periods of drought; unpredictable precipitation
2. High soil and leaf temperatures
3. Saline soils

Plants use anatomical, physiological and life history mechanisms for coping with harsh desert environments

1. DROUGHT TOLERATORS

1a. Evergreen shrubs

- "True xerophytes"
- High root-to-shoot ratio: take up a lot of water, transpire less. Cost: low maximum growth rates
- **Creosote bush** is prime example
  - Extensive rooting system helps collect moisture from large soil volume
  - Withstands very low water potentials
  - High rates of photosynthesis at high temperatures
  - Sheds some leaves in extreme drought
  - Flowers opportunistically

Jojoba is another drought tolerator

- Can alter leaf size and color (pubescence) depending on season of growth
- Leaf angle can respond to diurnal changes in sun angle

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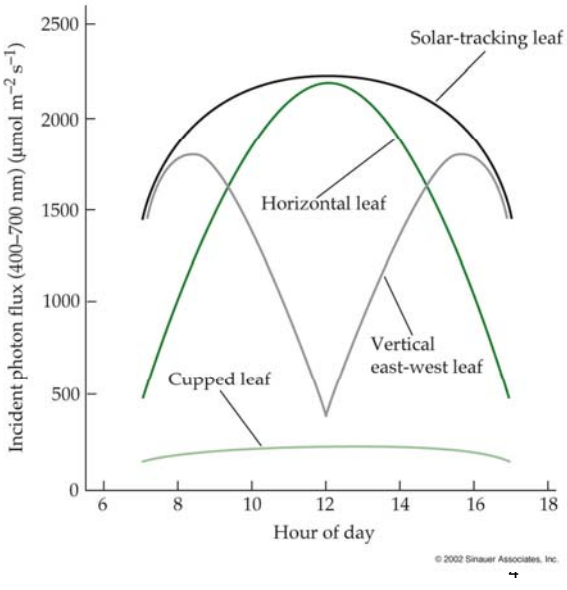
Leaf size and angle of orientation help reduce heat loading

- Plants cool by evapotranspiration when water is available
- Smaller leaves cool faster than large leaves (thinner boundary layers)
- Vertical leaves have highest irradiation in early morning and evening



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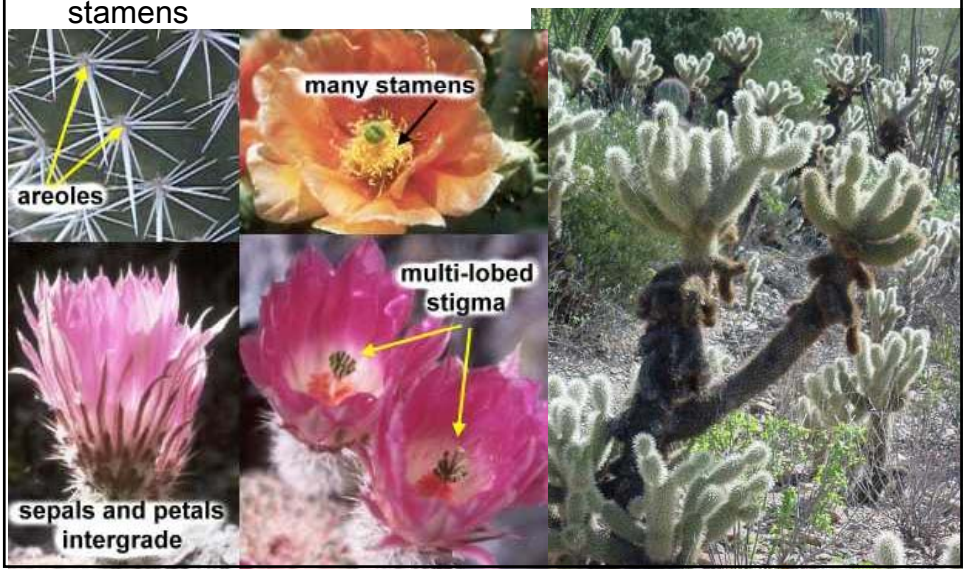
1b. Succulents: Cacti, “century” plants, and euphorbias

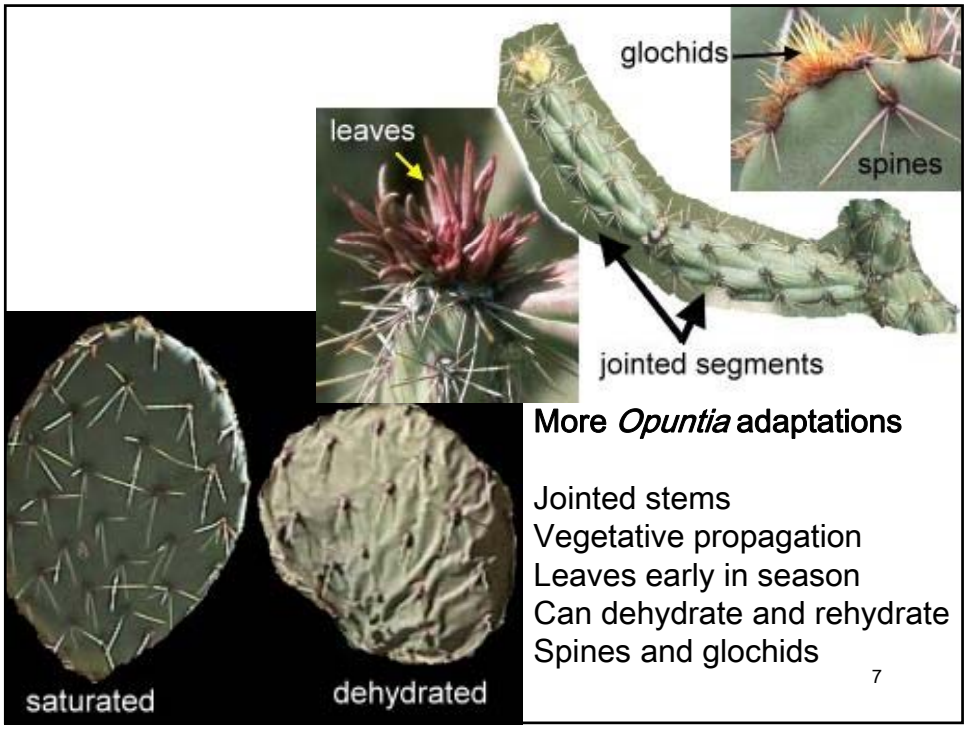
- Contain spongy parenchyma to store water
- Low surface-to-volume ratio
- Grow slowly, but some can become quite large
- Photosynthetic stems
- Shallow roots absorb water whenever possible
- Adaptations to minimize herbivory
  - Spines
  - Camouflage (e.g., stone plants, *Lithops* sp.)
- Many species not frost resistant
  - *O. polyacantha* can tolerate –17°C
- Physiological adaptations
  - CAM physiology (Figure)
  - High water use efficiency

What is a cactus?

Cactaceae is a New World family

Stem succulent with areoles, multi-lobed stigma, many stamens





More *Opuntia* adaptations

Jointed stems
Vegetative propagation
Leaves early in season
Can dehydrate and rehydrate
Spines and glochids

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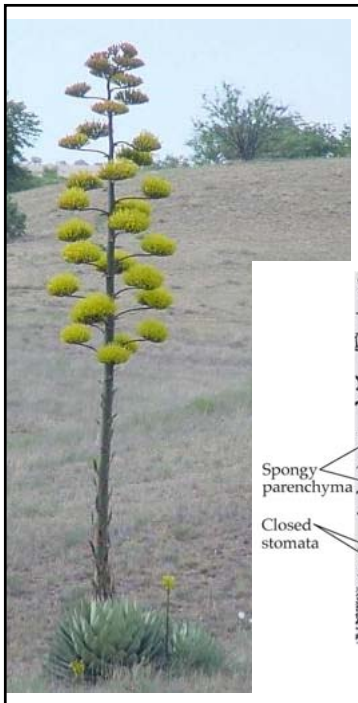
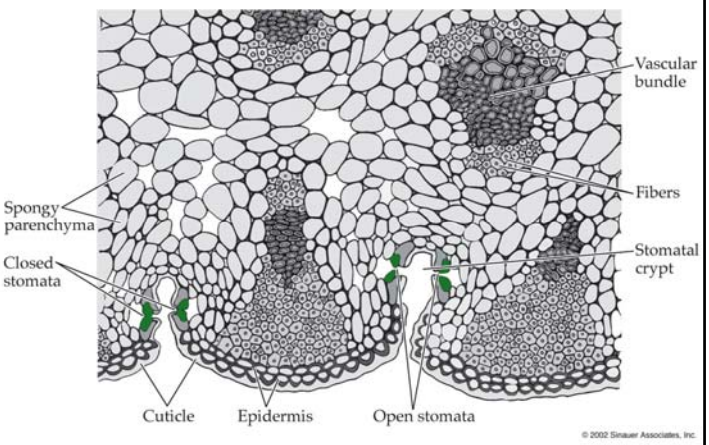
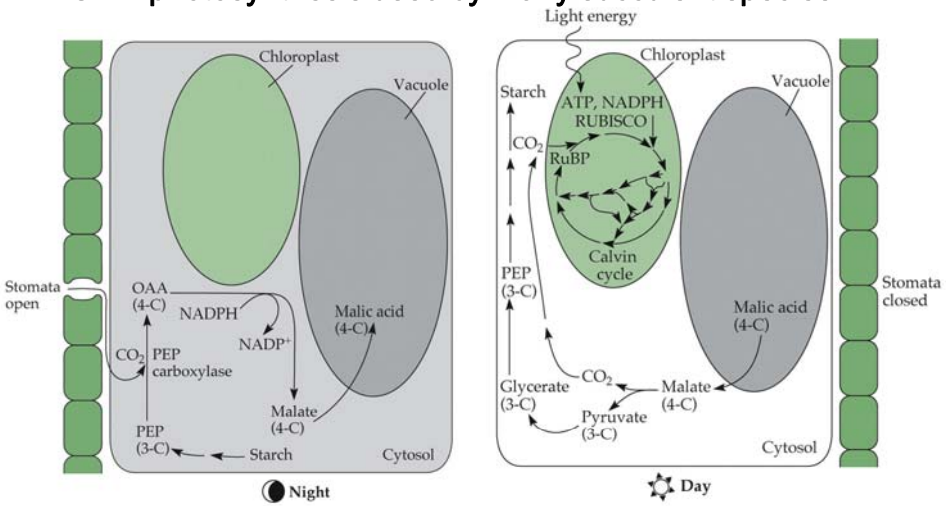


Parry's agave
Basal rosette of succulent leaves
Flowers once, then dies
(monocarpic, semelparous)
CAM photosynthesis



CAM photosynthesis used by many succulent species



CAM-idling: When conditions are extremely arid, CAM plants leave their stomata closed night and day. Oxygen given off in photosynthesis is used for respiration and CO2 given off in respiration is used for photosynthesis.

2. DROUGHT AVOIDERS

2a. Drought deciduous shrubs

- Leaves not drought tolerant but inexpensive to produce
- High maximum photosynthetic rates
- Limited photosynthetic period
- May have carbohydrate storage for rapid manufacture of new leaves when conditions become favorable

Ocotillo is drought-deciduous

- 4-5 leaf crops/year
- Leaf-out after rain
- Stems photosynthesize
- Very shallow roots

Blue paloverde is drought-deciduous

- Photosynthetic stems
- Microphyllous leaves
- One crop of leaves/year
- Thorns

2. DROUGHT AVOIDERS

2b. Phreatophytes

- Deep root systems tap into capillary fringe above water table
- Seeds of many legumes require scarification (abrasion by sand and gravel in stream) for germination
- Regeneration niche is critical
- Examples include cottonwoods, willows, some leguminous subtrees like mesquite

Velvet mesquite

- DEEP roots (to 160 ft!)
- Microphyllous leaves
- Winter deciduous
- Expanding across TX and southern NM in desert grassland

More about woody encroachment next week

2. DROUGHT AVOIDERS

2c. Ephemerals ("annuals")

- Grow only when water is available
- Life span of weeks to months
- Rapid photosynthetic and growth rates
- Cooled via transpiration (can't tolerate drought)
- May not possess xeromorphic features

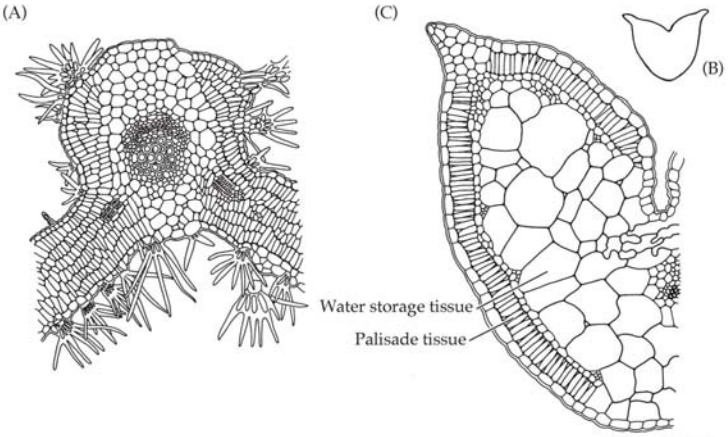
Summer annuals are more likely to have xeromorphic leaves

Desert mallow

- Stellate trichomes reduce water loss
- Palisade cells on both sides of leaf

Russian thistle

- Thick cuticle
- Water-storing cells



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2c. Ephemerals (con't)

Winter annuals

- Seeds germinate from Sept. to Dec. (N. Hemisphere)
- Mostly C3 plants
- Rosettes initially for warmth; elongate later
- Solar tracking of leaves (heliotropism) to maximize light collection during the short wet period, which is the only growing season

Summer annuals

- Seeds germinate after heavier rains in summer
- May be C4 plants
- Grow rapidly away from soil surface
- High photosynthetic rates on bright days

Seeds must withstand herbivory; high diversity of annuals correlates with rodent diversity!

3. HALOPHYTES

- Salt tolerant plants: saltbush, greasewood, saltgrass, and many others
- Salt secreting glands on leaves of some species
- Osmoregulation: organic acids and soluble carbohydrates create a high solute concentration in their cells. Why?
- Some think that CAM evolved first in response to salinity

Four-wing saltbush